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CONTRIBUTIONS TO THE BRYOPHYTE FLORA OF THE PAIKO, TZENA AND PINOVO MTS IN GREECE

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Abstract: 196 bryophyte taxa (30 liverworts and 166 mosses) were recorded in the investigated mountain areas. Five species (*Myurella sibirica, Plagiobryum zierii, Pohlia andalusica, Pseudoleskeella rupestris, Tortella fragilis*) are reported for the first time in Greece. Three species (*Seligeria pusilla, Syntrichia subpapillosissima, Taxiphyllum wissgrillii*) are reported for the first time from the Greek mainland. For two species (*Orthotrichum alpestre, Rhabdoweisia fugax*) the second records from Greece are reported. Six species (*Myurella sibirica, Neckera menziesii*, *Orthotrichum shawii, Pseudoleskeella rupestris*, *Plagiothecium platyphyllum, Schistidium papillosum)* are on the candidate list of the new Red data book of European bryophytes.

Key words: liverworts, mosses, new and interesting national records, European red list candidates

INTRODUCTION

The bryophyte flora of Greece is slowly being enriched with reports on new taxa. In the recent checklist and country red list status of European bryophytes (Hodgetts 2015) the majority of the reported taxa in Greece were included. Afterwards, the latest published reports give information mainly on the bryophyte flora of the Aegean Islands (Blockeel 2016, Blockeel and Neuwkoop 2016, Düll 2014, Kiebacher and Lüth 2016).

Most of the work published so far for Greece are providing data on the bryoflora of the Aegean Islands, Crete, and the southern part of the country, which are the most popular touristic parts and there are much fewer records from the mainland of Greece, especially from Northern Greece. For the Macedonia region of Northern Greece, records have started accumulating only the last years, providing many new taxa for the country. A PhD Thesis covering the aquatic system

of the Aliakmon River was one of the first reports covering a significant area of this region (Tsakiri 2009), followed by a number of reports mainly attributed to the collaboration of the Hungarian Natural History Museum of Budapest (Hungary) and the Laboratory of Systematic Botany and Phytogeography, Aristotle University of Thessaloniki (Greece) (Tsakiri *et al.* 2006, Papp and Tsakiri 2011, Papp *et al.* 2011*a*).

Some years before, during study trips in 2005 and 2010, Mt Voras was visited and a number of interesting new bryophyte records have been reported (Tsakiri *et al.* 2006, Papp *et al.* 2011*a*). As the Pinovo and Tzena Mts are situated next to Mt Voras towards East, it was decided to visit these areas, expanding the study also to the Mt Paiko area due to its vicinity and study the hepatics and mosses of the area. From the Pinovo and Tzena Mts there are no previous bryophyte records available, though for the Mt Paiko area one report exists providing data on bryophytes from a small area, the Skra-Koupa waterfalls (Megalo Rema stream) and its tuff formations (Papp and Tsakiri 2011).

As one of the members of our expedition in 2010 in Mt Voras was Peter Erzberger, we are glad to publish this paper in a volume in honour of his 70th birthday, as a continuation and extension of our joint bryological contribution to the area.

MATERIAL AND METHODS

Study area

The Pinovo (2154 m), Tzena (2182 m), and Paiko (1650 m) Mts are situated in central Northern Greece (Central Macedonia Administrative Region). The Pinovo and Tzena Mts stretch along the north-central border of Greece and together with the adjacent Mt Voras range, which is on their west side, form a natural mountain border with the Republic of Macedonia. Mt Paiko forms their continuum on an E–S direction of Mt Tzena.

Geologically the study area belongs to the "Paiko Zone" with the Pinovo and Tzena Mts. Substrates comprised mainly of schist and limestone, though Mt Paiko is formed mainly of limestone, ophiolites and on the Paiko's southeastern part mainly of sedimentary rocks (Dafis *et al.* 1996, 1985).

The climate is characterised as sub-Mediterranean with short, dry, and warm summer, though with severe winter weather reported in higher elevations (Korakis 2003, Athanasiadis and Drosos 1990).

Extensive, densely forested areas cover around 50% of the study area. A variety of habitats is reported, such as *Juniperus communis* formations on calcareous heaths or grasslands; *Quercus frainetto* forests; acidophilous beech for-

ests (*Luzulo-Fagetum*); nitrophilous beech forests (*Asperulo-Fagetum*); calcareous beech forests (Cephalanthero-Fagion); Platanion orientalis along streams; acidophilous spruce forests (Vaccinio-Piceetea), etc. From the Pinovo and Tzena Mts beech forests are also reported with *Ilex aquifolium* and *Taxus baccata* (Ilici-Fagion), Hellenic beech forests with *Abies borisii-regis* and at higher altitudes steep slopes with alpine and subalpine heaths. For Mt Paiko extensive *Castanea sativa* areas, forests of *Pinus nigra* subsp. *pallasiana* and *Taxus baccata* forests are additionally reported (Dafis *et al.* 1996).

The Pinovo and Tzena Mts form the "Ori Tzena" (GR1240002) and Mt Paiko the "Oros Paiko" (GR 1240003) "Special Areas of Conservation" in the framework of the Natura 2000 project, covering together more than 47,800 hectares (Dafis *et al.* 1996). The Pinovo and Tzena Mts form mountain peaks with steep slopes, though Mt Paiko, with its significantly lower altitude, has a milder relief. The area which was mostly affected by human activities is Mt Paiko with forests being heavily exploited and intensive grazing that led to the degradation of natural environment; only the last decades there are signs that recovery of natural vegetation has started.

METHODS

The collecting trip was made in August 2014. The investigated area is shown in Figure 1. Main habitat types, such as stream valleys, forests, and grasslands were investigated. Bryophytes were collected from different substrates (soil, exposed and shady rocks, tree bark, decaying wood). The specimens have been shared between the participating parties and are preserved in the Herbarium of the Hungarian Natural History Museum, Budapest (BP), and the bryophyte collection of Dr E. Tsakiri (Laboratory of Systematic Botany and Phytogeography, School of Biology, Aristotle University, Thessaloniki, Greece).

Nomenclature follows Grolle and Long (2000) for liverworts with the exception of *Conocephalum salebrosum*, which follows Szweykowski *et al.* (2005), and Hill *et al.* (2006) for mosses. New floristic results are given mainly according to the recently published "Checklist and country status of European bryophytes" (Hodgetts 2015). In some cases, other earlier and the most recently published works were also used (e.g. Düll 1995, Gallego 2005, Blockeel 2010, 2016, Blockeel and Neuwkoop 2016, Düll 2014, Kiebacher and Lüth 2016).

Site details

All sites are located in Central Macedonia (Greece).

1. Between Pinovo and Tzena Mts towards Pefka from Aetohori village, 41.106778° N, 22.1770° E, 1055 m, 21.08.2014.

2. Between Pinovo and Tzena Mts towards Pefka from Aetohori village, 41.117944° N, 22.172806° E, 1400 m, 21.08.2014.
3. Between Pinovo and Tzena Mts towards Pefka from Aetohori village, 41.118083° N, 22.165611° E, 1415 m, 21.08.2014.
4. Between Pinovo and Tzena Mts towards Pefka from Aetohori village, in *Fagetum*, 41.117528° N, 22.167167° E, 1350 m, 22.08.2014.
5. Between Pinovo and Tzena Mts towards Pefka from Aetohori village, 41.124722° N, 22.169778° E, 1340 m, 22.08.2014.
6. Between Pinovo and Tzena Mts, towards Pefka from Aetohori village, 41.105028° N, 22.182611° E, 860 m, 22.08.2014.
7. Mt Tzena, N of Notia village, 41.122583° N, 22.187028° E, 990 m, 22.08.2014.
8. Mt Tzena, N of Notia village, 41.129639° N, 22.180556° E, 1000 m, 22.08.2014.
9. Mt Tzena, N of Notia village, 41.111667° N, 22.223028° E, 685 m, 23.08.2014.
10. Mt Tzena, N of Notia village, 41.130278° N, 22.188306° E, 1280 m, 23.08.2014.
11. Mt Tzena, N of Notia village, 41.145972° N, 22.190806° E, 1540 m, 23.08.2014.
12. Mt Tzena, above Langadia village, 41.129722° N, 22.266944° E, 770 m, 25.08.2014.
13. Mt Tzena, above Langadia village in a *Fagetum*, 41.130611° N, 22.251° E, 1090 m, 25.08.2014.
14. Mt Paiko, between Kastaneri and Livadia, forest road above Vale Orvo, 40.974111° N, 22.304167° E, 1280 m, 24.08.2014.
15. Mt Paiko, between Kastaneri and Livadia, forest road above Vale Orvo towards Koufia Petra, 40.967722° N, 22.294083° E, 1390 m, 24.08.2014.

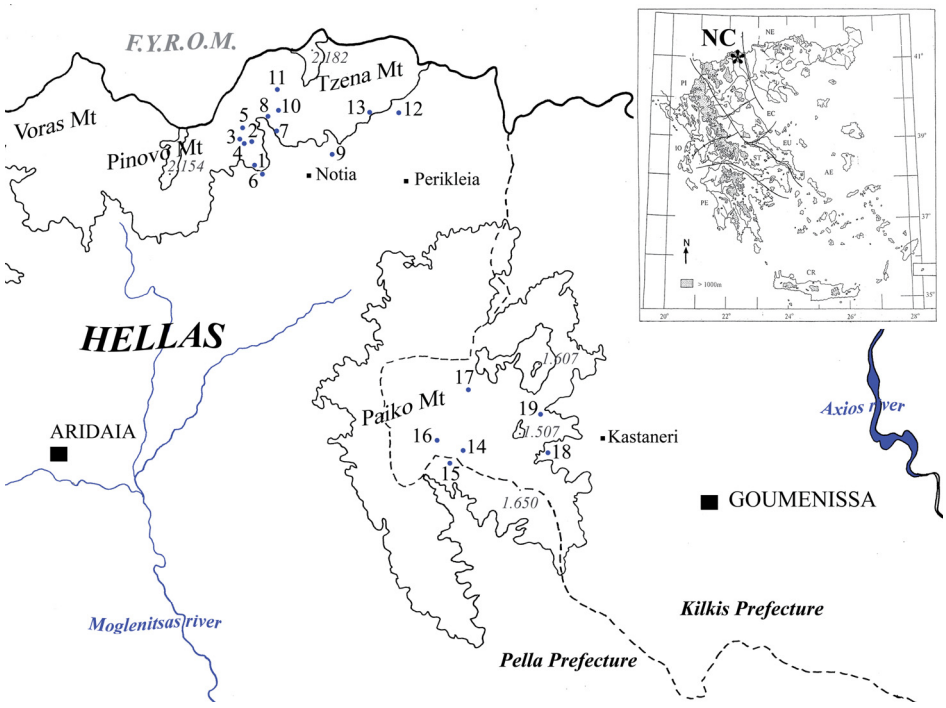

Fig. 1. The study area.

16. Mt Paiko, between Kastaneri and Livadia, forest road from Vale Orvo towards Gkrop and Mertzana, in a *Fagetum*, 40.974611° N, 22.287944° E, 1400 m, 24.08.2014.
17. Mt Paiko, near Livadia, at Mertzana stream, at the roadside, 40.99825° N, 22.297444° E, 1190 m, 24.08.2014.
18. Mt Paiko, above Kastaneri village, *Castanetum*, 40.971528° N, 22.351583° E, 980 m, 25.08.2014.
19. Mt Paiko, above Kastaneri village, Stravopotamu stream, Pramatari tourist path in a *Fagetum*, 40.989583° N, 22.346306° E, 1095 m, 26.08.2014.

RESULTS AND DISCUSSION

196 bryophyte taxa (30 liverworts and 166 mosses) were recorded in the investigated mountain areas. The complete list of the species can be found in the Appendix.

New and interesting records for Greece

Myurella sibirica (Müll. Hal.) Reimers is a subarctic, alpine element (Düll 1985). It is reported for the first time in Greece. In SE Europe it is known only from Slovenia and Bosnia-Herzegovina according to Sabovljević *et al.* (2008) and has been only recently reported from Montenegro and Serbia (Papp *et al.* 2014*a*). According to the Red data book of European bryophytes (ECCB 1995) it is considered as endangered (E) in Europe. It is on the candidate list of the new Red data book of European bryophytes (Hodgetts 2015). It is known only from a few countries in Europe; in Austria it is considered as potentially endangered (Grims 1999), and in Slovakia as endangered (EN) (Kubinská *et al.* 2001). It lives on shaded limestone rocks, on soil at cliff bases (ECCB 1995). It was collected on a lime containing schistose rock in Mt Tzena above 1500 m at the edge of a beech forest close to its border with alpine zone. It occurred together with *M. julacea* (Schwägr.) Schimp.

Orthotrichum alpestre Bruch et Schimp. is a subarctic, subalpine (Düll 1985) epiphyte species. It had one old report in Düll (1995) from Pindos area by Haussknecht (1899), which needed verification. Later on, it has been verified for the Pindos area by Lara *et al.* (2003). It was recently collected in Mt Paiko from decaying *Fagus* bark. This is the second verified record of the species from Greece.

Plagiobryum zieri (Hedw.) Lindb. is a subarctic, subalpine element (Düll 1985) living in shaded limestone rock crevices (Smith 2004). It is reported for the first time in Greece. It was known from almost all SE European countries except Kosovo, the European part of Turkey, and Greece (Hodgetts 2015). It was collected on a lime containing schistose rock in Mt Tzena in a beech forest above 1500 m, close to its border with alpine zone.

Pohlia andalusica (Höhn.) Broth. is a sub-Atlantic, montane element (Düll 1984) occurring on damp sandy soil and clay (Smith 2004). It is reported for the first time in Greece. In SE Europe it is known only from Montenegro, Republic of Macedonia, Serbia, and Romania, where it is red-listed as data deficient (DD) (Hodgetts 2015). It was collected from acidic soil in Mt Tzena above 1500 m, at the edge of a beech forest close to its border with alpine zone.

Pseudoleskeella rupestris (Berggr.) Hedenäs et L. Söderstr. is a circumpolar, boreal, montane (Smith 2004) species previously treated as a variety of *P. catenulata*. This moss is newly reported for the Balkans, from Montenegro (Dragićević *et al*. 2008), Albania (Papp *et al.* 2010), Serbia (Papp *et al.* 2014*b*), Croatia (Alegro *et al.* 2015), and the Republic of Macedonia (Papp *et al.* 2016*a*). From the Mediterranean region it is known from Spain, France, and Turkey (Ros *et al*. 2013). It is reported for the first time in Greece. It is on the candidate list of the new Red data book of European bryophytes (Hodgetts 2015). It usually occurs on limestone rocks (Smith 2004). It was collected in Mt Paiko from limestone rock on the bank of a stream in a beech forest.

Rhabdoweisia fugax (Hedw.) Bruch et Schimp. is a boreal, montane species (Düll 1984) occurring on non-basic rock crevices, cliffs (Smith 2004). It was reported from the neighbouring Mt Voras as new species for the Greek bryoflora (Papp *et al.* 2011*a*). It was collected between the Pinovo and Tzena Mts, in crevices of exposed acidic rock situated above 1400 m. It is the second record of the species from Greece.

Schistidium confertum (Funck) Bruch et Schimp. is a subboreal, montane species (Düll 1984). It was included with question mark for North Central Greece in Düll (1995) (*Schistidium apocarpum* cf. var. *confertum*). Later it was reported from the Pindos area, Mt Smolikas by Blockeel (2010). It was also collected in the neighbouring Mt Tzena from siliceous rock (Papp *et al.* 2011*a*). However, the occurrence of the species is questionable for Greece in Hodgetts (2015). It was collected again from exposed acidic rocks in the Pinovo and Tzena Mts.

Seligeria pusilla (Hedw.) Bruch et Schimp. is a tiny species of the temperate zone of Europe (Düll 1984) living in calcareous rock crevices, shaded, humid vertical cliffs (Smith 2004). Its occurrence is questionable for Greece in Hodgetts (2015), although it was reported by Düll (1995) from Crete and some old records are also mentioned for the Ionian islands by Greville (1827) and Bottini (1913). It was found in Mt Tzena on lime containing schist and in Mt Paiko on shaded limestone rocks. This is the first record of the species from the mainland of Greece.

Syntrichia subpapillosissima (Bizot et R. B. Pierrot ex W. A. Kramer) M. T. Gallego et J. Guerra is an Atlantic, Mediterranean element according to Düll (1984) and occurs on soil and acidic rocks (Gallego 2006). It was reported

from Crete by Gallego (2005). In Hodgetts (2015) there is no record for SE Europe. However, it has been recently reported from Croatia (Papp *et al.* 2013*a*) and from the Republic of Macedonia (Papp *et al.* 2016*a*). It was found on exposed acidic rocks in Mt Tzena. This is its first record from the mainland of Greece.

Taxiphyllum wissgrillii (Garov.) Wijk et Margad. is a sub-Atlantic species (Düll 1985) growing on shaded limestone rocks (Smith 2004). According to Hodgetts (2015) it was known from almost all SE European countries, except Albania, Kosovo, the Republic of Macedonia, and Greece. However, in Düll (1995) it was reported from Crete. Later on it has been reported from the Republic of Macedonia (Papp *et al.* 2016*a*). It is red-listed in Bulgaria (VU) (Hodgetts 2015). It was collected in Mt Paiko from shaded limestone rocks in a deep valley covered with beech forest. This is the first record of the species from the mainland of Greece.

Tortella fragilis (Hook. et Wilson) Limpr. is a subarctic, subalpine species (Düll 1984) living on basic rocks (Smith 2004). It is reported for the first time in Greece. It has been reported from several SE European countries, e.g. Bosnia-Herzegovina, Bulgaria, Montenegro, Romania, Serbia, Slovenia (Hodgetts 2015) and recently from Croatia (Papp *et al.* 2013*a*) and the Republic of Macedonia (Papp *et al.* 2016*a*). It is red-listed in Bulgaria (VU) (Hodgetts 2015). It was collected from exposed acidic rocks in the alpine zone of Mt Tzena above 1500 m.

Species of European conservation interest – candidates of the new Red data book of European bryophytes

Myurella sibirica (Müll. Hal.) Reimers and *Pseudoleskeella rupestris* (Berggr.) Hedenäs et L. Söderstr. have already been mentioned above as new species for the Greek bryoflora and candidates of the new Red data book of European bryophytes (Hodgetts 2015). *Myurella sibirica* is also included in the Red data book of European bryophytes in the endangered (E) category (ECCB 1995).

Neckera menziesii Drumm. is a sub-Mediterranean, sub-Atlantic, montane element (Düll 1985) occurring on shaded siliceous or calcareous rocks (Ahrens 2001, Cortini Pedrotti 2006). It is red-listed in many Central European countries (Hodgetts 2015), but probably it is not so rare in SE Europe evidenced even by our many recent collections from Serbia: Golija Biosphere Reserve, Suva Mts, Pešter plateau (Papp and Erzberger 2005, 2009, Papp *et al.* 2014*c*), from Montenegro: Lovćen, Durmitor, Bjelasica Mts (Papp and Erzberger 2007*a*, 2010, Papp *et al.* 2013*b*), from Bulgaria, Strandzha Mts (Papp *et al.* 2011*b*), from Albania (Papp *et al.* 2010), from the Republic of Macedonia, Mavrovo Mts (Papp *et al.* 2016*b*). It was also reported from the neighbouring Mt Voras in Greece (Papp *et al*. 2011*a*).

Orthotrichum shawii Wilson is a southern sub-Atlantic epiphyte species (Smith 2004). It has been recently separated from its close relative, *O. striatum* (Mazimpaka *et al.* 2000). In SE Europe it is known only from Albania and Greece (Hodgetts 2015) and it has recently been reported from the Republic of Macedonia (Papp *et al.* 2016*a*).

Plagiothecium platyphyllum Mönk. is a sub-Atlantic species (Düll 1985) occurring on humid acidic soil and rocks (Smith 2004). It is red-listed in many European countries and even in SE Europe it is vulnerable (VU) in Bulgaria and near threatened (NT) in Romania (Hodgetts 2015). However, in the Balkans several existing populations are known on the base of our recent collections in Croatia: Gorski kotar, Plitvice lakes, Žumberačko Mts (Papp *et. al.* 2013*c*, Alegro *et al.* 2014, 2015), in Montenegro: Durmitor, Bjelasica Mts (Papp and Erzberger 2010, Papp *et al.* 2013*b*), in Serbia: Golija Biosphere Reserve (Papp and Erzberger 2005), in the Republic of Macedonia: Pelister Mts (Papp and Erzberger 2012). It was also reported from the neighbouring Voras Mts in Greece (Papp *et al.* 2011a).

Schistidium papillosum Culm. is a circumpolar, boreo-arctic, montane species (Smith 2004) living mostly on exposed or half-shaded siliceous rocks (Nebel and Holz 2000). As it has recently been reported from many countries in SE Europe it is in the data-deficient (DD) category in most national red lists (Hodgetts 2015). According to our recent collections it does not seem to be rare in the Balkans in the higher mountain areas on exposed acidic rocks, e.g. Stara Planina Mts, Stolovi Mt at Ibar gorge and mountains around Vlasina lake in Serbia (Papp and Erzberger 2007*b*, Papp *et al.* 2012, 2016*c*), Bjelasica Mts in Montenegro (Papp *et al.* 2013*b*), and some Albanian collections (Papp, unpublished).

CONCLUSIONS

According to Hodgetts (2015) and the current paper the bryophyte flora of Greece consists of 732 taxa (158 liverworts and 574 mosses). The number of known taxa from Greece is higher than in the neighbouring countries, e.g. Republic of Macedonia with 546 or Albania with 466 taxa, but lower than in Bulgaria, where the bryoflora counts 807 taxa. It can be concluded that the Greek bryoflora is not understudied, but still every field expedition can add new records to the bryophyte checklist. Especially in the northern part of the country several, bryologically still unexplored, interesting areas can be found.

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Összefoglaló: 196 mohát (30 májmohát és 166 lombosmohát) találtunk a vizsgált észak-görögországi hegyekben. Öt fajt (*Myurella sibirica*, *Plagiobryum zierii*, *Pohlia andalusica*, *Pseudoleskeella rupestris*, *Tortella fragilis*) először sikerült kimutatnunk Görögország területéről. Három fajnak (*Seligeria pusilla*, *Syntrichia subpapillosissima*, *Taxiphyllum wissgrillii*) az első adatát közöljük a görög félszigetről. Két fajnak (*Orthotrichum alpestre*, *Rhabdoweisia fugax*) ez a második adata az országban. Hat faj (*Myurella sibirica*, *Neckera menziesii*, *Orthotrichum shawii*, *Pseudoleskeella rupestris*, *Plagiothecium platyphyllum*, *Schistidium papillosum)* természetvédelmi szempontból is érdekes, mivel szerepelnek a potenciális új Európai Moha Vörös Listán.

Görögország mohaflórája így jelenleg 732 fajt számlál, ami több mint a szomszédos Macedóniában (546) vagy Albániában (466) regisztrált fajok száma, de kevesebb, mint a Bulgáriában található fajok száma (807). Görögország mohaflórája eléggé feltártnak mondható, de szinte még minden expedíció új fajokat ad az ország mohaflórájához. Főleg az ország északi részén található hegyvidékek kevésbé kutatottak, így az ide irányuló terepkutatásoktól további új adatokat remélhetünk.

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Appendix – Complete list of bryophyte records

The numerals following the species names refer to the collection sites described above.

Liverworts

Aneura pinguis (L.) Dumort. – 11: at a rivulet
Apometzgeria pubescens (Schrank) Kuwah. – 16: shaded limestone rock
Barbilophozia hatcheri (A. Evans) Loeske – 11: exposed acidic rock
Cephaloziella divaricata (Sm.) Schiffn. – 3: exposed acidic rock; 11: soil
Chiloscyphus pallescens (Ehrh. ex Hoffm.) Dumort. – 19: at the stream
Chiloscyphus polyanthus (L.) Corda – 7: at a rivulet
Conocephalum conicum (L.) Dumort. – 11: at a rivulet
Conocephalum salebrosum Szweykowski, Buczkowska et Odrzykoski –19: at the stream
Frullania dilatata (L.) Dumort. – 3, 14: bark of *Fagus*; 8, 13: acidic rock; 18: bark of *Castanea sativa*
Jungermannia atrovirens Dumort. – 11: at a rivulet
Jungermannia hyalina Lyell – 11, 14: soil
Jungermannia leiantha Grolle – 11: soil
Leiocolea badensis (Gottsche) Jörg. – 11: lime containing schist
Leiocolea collaris (Nees) Schljakov – 11: lime containing schist; 16, 19: shaded limestone rock; 17: limestone rock
Lejeunea cavifolia (Ehrh.) Lindb. – 19: shaded limestone rock
Lophocolea heterophylla (Schrad.) Dumort. – 14: soil
Lophocolea minor Nees – 11: lime containing schist and soil at a rivulet; 14: soil; 19: shaded limestone rock
Lophozia bicrenata (Schmidel ex Hoffm.) Dumort. – 14: soil
Marchantia polymorpha L. subsp. ***ruderalis*** Bischl. et Boisselier – 11: at a rivulet
Metzgeria conjugata Lindb. – 19: shaded limestone rock
Metzgeria furcata (L.) Dumort. – 3: bark of *Fagus*; 4: acidic conglomerate rock; 7: decaying wood; 11: lime containing schist; 16, 19: shaded limestone rock
Pedinophyllum interruptum (Nees) Kaal. – 16, 19: shaded limestone rock
Pellia endiviifolia (Dicks.) Dumort. – 8: at the stream; 11: lime containing schist and soil at a rivulet; 19: at the stream
Plagiochila porelloides (Torrey ex Nees) Lindenb. – 7: soil and at a rivulet; 8: at the stream; 11: lime containing schist; 16, 19: shaded limestone rock

Porella cordaeana (Huebener) Mohr – 3: shaded acidic rock and bark of *Fagus*; 4: acidic conglomerate rock; 8: acidic rock; 11: lime containing schist
Porella platyphylla (L.) Pfeiff. – 7: schistose rock
Preissia quadrata (Scop.) Nees – 11: lime containing schist; 17: limestone rock
Radula complanata (L.) Dumort. – 3, 14: bark of *Fagus*; 7: soil and decaying wood; 11: lime containing schist; 12: acidic rock
Reboulia hemisphaerica (L.) Raddi – 11: lime containing schist; 16, 19: shaded limestone rock
Scapania calcicola (Arnell et J. Perss.) Ingham – 11: soil

Mosses

Abietinella abietina (Hedw.) M. Fleisch. – 17: limestone rock
Aloina ambigua (Bruch et Schimp.) Limpr. – 6, 9: sandy loess wall
Amphidium mougeotii (Schimp.) Schimp. – 11: lime containing schist; 19: shaded limestone rock
Anomodon attenuatus (Hedw.) Huebener – 8: acidic rock; 19: shaded limestone rock and *Fagus* bark
Anomodon longifolius (Schleich. ex Brid.) Hartm. – 19: shaded limestone rock and *Fagus* bark
Anomodon viticulosus (Hedw.) Hook. et Taylor – 8: at the stream; 16, 19: shaded limestone rock
Antitrichia curtipendula (Hedw.) Brid. – 4: acidic conglomerate rock; 8: acidic rock
Atrichum undulatum (Hedw.) P. Beauv. – 4: soil; 7, 11: at a rivulet
Barbula convoluta Hedw. – 11: soil and lime containing schist
Barbula unguiculata Hedw. – 2: schistose rock; 6: sandy loess wall; 11: soil
Bartramia halleriana Hedw. – 11: lime containing schist; 19: shaded limestone rock
Bartramia ithyphylla Brid. – 4: soil; exposed acidic rock; 19: shaded limestone rock
Bartramia pomiformis Hedw. – 19: shaded limestone rock
Brachytheciastrum velutinum (Hedw.) Ignatov et Huttunen – 1: acidic rock; 4: soil and decaying wood; 7: soil and decaying wood; 11: soil at a rivulet; 13: acidic rock; 14: soil; 16: shaded limestone rock; 19: shaded limestone rock and decaying wood
Brachythecium glareosum (Bruch ex Spruce) Schimp. – 11: lime containing schist and exposed acidic rock; 19: shaded limestone rock
Brachythecium rivulare Schimp. – 7, 11: at a rivulet; 8, 19: at the stream
Brachythecium rutabulum (Hedw.) Schimp. – 4: acidic conglomerate rock; 8, 18: soil; 16: shaded limestone rock; 19: shaded limestone rock and rock at the stream
Brachythecium tommasinii (Sendtn. ex Boulay) Ignatov et Huttunen – 16, 19: shaded limestone rock
Bryoerythrophyllum recurvirostrum (Hedw.) P. C. Chen – 11: lime containing schist; 12: sandy conglomerate loess wall; 15: exposed limestone rock; 19: shaded limestone rock
Bryum argenteum Hedw. – 6: sandy loess wall; 15: exposed limestone rock
Bryum caespiticium Hedw. – 2: schistose rock; 12: sandy conglomerate loess wall; 15: exposed limestone rock
Bryum capillare Hedw. – 12: sandy conglomerate loess wall; 14: soil
Bryum dichotomum Hedw. – 15: exposed limestone rock
Bryum moravicum Podp. – 4: soil and decaying wood; 14: *Fagus* bark
Bryum pallens Sw. ex anon. – 11: at a rivulet; 17: limestone rock
Bryum pallescens Schleich. ex Schwägr. – 2: schistose rock; 11: soil
Bryum pseudotriquetrum (Hedw.) P. Gaertn. *et al.* – 11: at a rivulet
Campyliadelphus chrysophyllus (Brid.) R. S. Chopra – 11: at a rivulet
Campylophyllum calcareum (Crundw. et Nyholm) Hedenäs – 19: shaded limestone rock and decaying wood
Ceratodon purpureus (Hedw.) Brid. – 2: schistose rock; 11: soil and exposed acidic rock

Cirriphyllum crassinervium (Taylor) Loeske et M. Fleisch. – 4: acidic conglomerate rock; 19: shaded limestone rock
Cratoneuron filicinum (Hedw.) Spruce – 7: at a rivulet; 8: at the stream; 11: lime containing schist
Crossidium squamiferum (Viv.) Jur. – 6: sandy loess wall
Ctenidium molluscum (Hedw.) Mitt. – 8: soil; 11: lime containing schist; 16, 19: shaded limestone rock
Dichodontium pellucidum (Hedw.) Schimp. – 19: shaded limestone rock
Dicranella heteromalla (Hedw.) Schimp. – 14: soil
Dicranella varia (Hedw.) Schimp. – 2: schistose rock; 11, 14: soil
Dicranum scoparium Hedw. – 7: schistose rock; 8, 14: soil; 11: lime containing schist; 19: shaded limestone rock
Didymodon acutus (Brid.) K. Saito – 15: exposed limestone rock
Didymodon fallax (Hedw.) R. H. Zander – 2: schistose rock; 14: soil; 17: limestone rock
Didymodon insulanus (De Not.) M. O. Hill – 4: soil; 7: at a rivulet; 16, 19: shaded limestone rock; 18: soil
Didymodon luridus Hornsch. – 6, 9: sandy loess wall; 15: exposed limestone rock
Didymodon rigidulus Hedw. – 6, 9: sandy loess wall; 11: lime containing schist; 16: shaded limestone rock
Didymodon sicculus M. J. Cano, Ros, García-Zamora et J. Guerra – 5: schistose rock
Didymodon sinuosus (Mitt.) Delogne – 12: sandy conglomerate loess wall
Didymodon spadiceus (Mitt.) Limpr. – 11: at a rivulet
Didymodon vinealis (Brid.) R. H. Zander – 12: sandy conglomerate loess wall
Diphyscium foliosum (Hedw.) D. Mohr – 11: soil
Distichium capillaceum (Hedw.) Bruch et Schimp. – 2: schistose rock; 11: lime containing schist; 16: shaded limestone rock
Ditrichum flexicaule (Schwägr.) Hampe – 3: exposed acidic rock; 11: lime containing schist; 15: exposed limestone rock
Ditrichum pusillum (Hedw.) Hampe – 11: soil
Encalypta ciliata Hedw. – 11: lime containing schist
Encalypta streptocarpa Hedw. – 2: schistose rock; 16, 19: shaded limestone rock; 17: limestone rock
Encalypta vulgaris Hedw. – 12: sandy conglomerate loess wall
Eurhynchiastrum pulchellum (Hedw.) Ignatov et Huttunen var. ***pulchellum*** – 7: soil
Eurhynchiastrum pulchellum (Hedw.) Ignatov et Huttunen var. ***diversifolium*** (Schimp.) Ochyra et Zarnowiec – 11, 14: soil
Eurhynchium angustirete (Broth.) T. J. Kop. – 11: lime containing schist
Fissidens dubius P. Beauv. – 8: at the stream; 11: lime containing schist; 16, 19: shaded limestone rock
Fissidens taxifolius Hedw. – 11: lime containing schist; 14: soil; 19: shaded limestone rock
Fissidens viridulus (Sw. ex Anon.) Wahlenb. – 11, 14: soil
Grimmia laevigata (Brid.) Brid. – 1, 12: acidic rock
Grimmia muehlenbeckii Schimp. – 4: acidic conglomerate rock; 8, 12: acidic rock
Grimmia orbicularis Bruch ex Wilson – 2: schistose rock
Grimmia ovalis (Hedw.) Lindb. – 3, 11: exposed acidic rock; 13: acidic rock
Grimmia pulvinata (Hedw.) Sm. – 1: acidic rock; 2: schistose rock; 3: exposed acidic rock; 6: sandy loess wall; 12: sandy conglomerate loess wall
Grimmia tergestina Tomm. ex Bruch et Schimp. – 3: exposed acidic rock; 15: exposed limestone rock
Gymnostomum aeruginosum Sm. – 11: lime containing schist
Gymnostomum calcareum Nees et Hornsch. – 11: at a rivulet
Hedwigia ciliata (Hedw.) P. Beauv. – 8, 10, 13: acidic rock
Herzogiella seligeri (Brid.) Z. Iwats. – 19: decaying wood

Homalothecium philippeanum (Spruce) Schimp. – 2: schistose rock; 4: acidic conglomerate rock, 10: acidic rock; 19: shaded limestone rock and *Fagus* bark
Homalothecium sericeum (Hedw.) Schimp. – 1, 12, 13: acidic rock; 3, 4, 14: bark of *Fagus*; 7: soil and decaying wood; 8: decaying wood; 16, 19: shaded limestone rock
Homomallium incurvatum (Schrad. ex Brid.) Loeske – 19: shaded limestone rock and at the stream
Hygroamblystegium tenax (Hedw.) Jenn. –19: at the stream
Hygrohypnum luridum (Hedw.) Jenn. – 8, 19: at the stream; 11: at a rivulet
Hylocomium splendens (Hedw.) Schimp. – 11: soil; 17: limestone rock
Hypnum cupressiforme Hedw. var. ***cupressiforme*** – 4: acidic conglomerate rock; 7: soil and schistose rock; 8: decaying wood; 13: acidic rock; 14: soil and *Fagus* bark; 18: bark of *Castanea sativa*
Hypnum cupressiforme Hedw. var. ***lacunosum*** Brid. – 1: acidic rock; 3: exposed acidic rock
Isothecium alopecuroides (Lam. ex Dubois) Isov. – 4: acidic conglomerate rock and bark of *Fagus*; 7: schistose rock; 8: acidic rock; 11: lime containing schist; 16: shaded limestone rock; 19: shaded limestone rock and *Fagus* bark
Leucodon sciuroides (Hedw.) Schwägr. – 3: exposed acidic rock and bark of *Fagus*; 8: acidic rock and decaying wood; 12: acidic rock and bark of *Quercus pubescens;* 14: *Fagus* bark
Mnium marginatum (Dicks.) P. Beauv. – 11: lime containing schist; 16, 19: shaded limestone rock
Mnium stellare Hedw. – 7: at a rivulet; 8: at the stream; 11, 14: soil; 16, 19: shaded limestone rock
Mnium thomsonii Schimp. – 11: lime containing schist
Myurella julacea (Schwägr.) Schimp. – 11: lime containing schist
Myurella sibirica (Müll. Hal.) Reimers – 11: lime containing schist
Neckera besseri (Lobarz.) Jur. – 19: shaded limestone rock
Neckera complanata (Hedw.) Huebener – 19: shaded limestone rock and *Fagus* bark
Neckera crispa Hedw. – 19: shaded limestone rock
Neckera menziesii Drumm. – 16: shaded limestone rock; 19: shaded limestone rock and decaying wood
Orthothecium intricatum (Hartm.) Schimp. – 11: lime containing schist
Orthotrichum affine Schrad. ex Brid. – 1: acidic rock and bark of *Ostrya carpinifolia*; 12: bark of *Quercus pubescens*; 18: bark of *Castanea sativa*
Orthotrichum alpestre Bruch et Schimp. – 19: decaying wood
Orthotrichum anomalum Hedw. – 12: limestone rock
Orthotrichum cupulatum Hoffm. ex Brid. – 11: exposed acidic rock; 19: shaded limestone rock
Orthotrichum lyellii Hook. et Taylor – 4, 14: bark of *Fagus;* 12: bark of *Quercus pubescens;* 18: bark of *Castanea sativa*
Orthotrichum pallens Bruch ex Brid. – 14: *Fagus* bark; 18: bark of *Castanea sativa*
Orthotrichum pumilum Sw. ex anon. – 12: bark of *Quercus pubescens*
Orthotrichum rupestre Schleich. ex Schwägr. – 4: acidic conglomerate rock; 7: schistose rock; 8, 12: acidic rock
Orthotrichum shawii Wilson – 1: bark of *Ostrya carpinifolia*
Orthotrichum speciosum Nees – 18: bark of *Castanea sativa*
Orthotrichum stramineum Hornsch. ex Brid. – 14: *Fagus* bark; 18: bark of *Castanea sativa*
Orthotrichum striatum Hedw. – 1: acidic rock and bark of *Ostrya carpinifolia*; 3, 14: bark of *Fagus;* 18: bark of *Castanea sativa*
Oxyrrhynchium hians (Hedw.) Loeske – 7: at a rivulet; 11: lime containing schist
Oxyrrhynchium schleicheri (R. Hedw.) Röll – 7: soil; 16, 19: shaded limestone rock
Palustriella commutata (Hedw.) Ochyra – 11: at a rivulet
Philonotis fontana (Hedw.) Brid. – 11: at a rivulet
Philonotis seriata Mitt. – 11: at a rivulet
Plagiobryum zieri (Hedw.) Lindb. – 11: lime containing schist

Plagiomnium cuspidatum (Hedw.) T. J. Kop. – 7: at a rivulet
Plagiomnium rostratum (Schrad.) T. J. Kop. – 16, 19: shaded limestone rock
Plagiomnium undulatum (Hedw.) T. J. Kop. – 7: at a rivulet; 19: at the stream
Plagiopus oederianus (Sw.) H. A. Crum et L. E. Anderson – 11: lime containing schist; 16, 19: shaded limestone rock
Plagiothecium cavifolium (Brid.) Z. Iwats. – 4: soil and acidic conglomerate rock; 7: at a rivulet; 8: at the stream; 11: lime containing schist
Plagiothecium denticulatum (Hedw.) Schimp. – 14: *Fagus* bark
Plagiothecium platyphyllum Mönk. – 7: soil
Plasteurhynchium striatulum (Spruce) M. Fleisch. – 16, 19: shaded limestone rock
Platydictya jungermannoides (Brid.) H. A. Crum – 16, 19: shaded limestone rock
Platyhypnidium riparioides (Hedw.) Dixon – 8, 19: at the stream
Pogonatum aloides (Hedw.) P. Beauv. – 4, 11, 14: soil
Pohlia andalusica (Höhn.) Broth. – 11: soil
Pohlia cruda (Hedw.) Lindb. – 2: schistose rock; 4: soil; 17: limestone rock; 19: shaded limestone rock
Pohlia melanodon (Brid.) A. J. Shaw – 7: at a rivulet; 14: soil
Pohlia wahlenbergii (F. Weber et D. Mohr) A. L. Andrews – 11: soil at a rivulet; 14: soil; 17: limestone rock
Polytrichastrum alpinum (Hedw.) G. L. Sm. – 2: schistose rock; 11: soil
Polytrichastrum formosum (Hedw.) G. L. Sm. – 8, 14: soil
Polytrichum juniperinum Hedw. – 2: schistose rock; 11: soil
Pseudocrossidium revolutum (Brid.) R. H. Zander – 15: exposed limestone rock
Pseudoleskea incurvata (Hedw.) Loeske – 11: lime containing schist
Pseudoleskea saviana (De Not.) Latzel – 3: bark of *Fagus*; 4: acidic conglomerate rock; 11: decaying wood; 16: shaded limestone rock
Pseudoleskeella catenulata (Brid. ex Schrad.) Kindb. – 11: exposed acidic rock
Pseudoleskeella nervosa (Brid.) Nyholm – 3: bark of *Fagus*; 4: decaying wood; 11: lime containing schist and at a rivulet; 13: acidic rock; 19: shaded limestone rock
Pseudoleskeella rupestris (Berggr.) Hedenäs et L. Söderstr. –19: at the stream
Pseudoscleropodium purum (Hedw.) M. Fleisch. – 17: limestone rock; 18: soil
Pterigynandrum filiforme Hedw. – 3, 14: bark of *Fagus*; 4: acidic conglomerate rock; 7: soil and schistose rock and decaying wood; 11: lime containing schist; 13: acidic rock; 18: bark of *Castanea sativa*; 19: decaying wood
Pterygoneurum ovatum (Hedw.) Dixon – 15: exposed limestone rock
Racomitrium canescens (Hedw.) Brid. – 11: exposed acidic rock
Rhabdoweisia fugax (Hedw.) Bruch et Schimp. – 3: exposed acidic rock
Rhizomnium punctatum (Hedw.) T. J. Kop. – 7: at a rivulet; 8: at the stream; 19: at the stream
Rhynchostegium murale (Hedw.) Schimp. – 11: at a rivulet and lime containing schist
Rhytidiadelphus triquetrus (Hedw.) Warnst. – 11: soil
Saelania glaucescens (Hedw.) Broth. – 11: lime containing schist
Schistidium apocarpum (Hedw.) Bruch et Schimp. – 3: shaded acidic rock; 7: schistose rock
Schistidium brunnescens Hedw. subsp. ***griseum*** (Nees et Hornsch.) H. H. Blom – 15: exposed limestone rock
Schistidium confertum (Funck) Bruch et Schimp. – 3: exposed acidic rock; 11: exposed acidic rock
Schistidium crassipilum H. H. Blom – 2: schistose rock, 8: acidic rock at the stream; 11: lime containing schist and exposed acidic rock; 16, 19: shaded limestone rock; 17: limestone rock
Schistidium dupretii (Thér.) W. A. Weber – 11: at a rivulet
Schistidium papillosum Culm. – 11: exposed acidic rock

Sciuro-hypnum populeum (Hedw.) Ignatov et Huttunen – 8: acidic rock
Scleropodium touretii (Brid.) L. F. Koch – 7: soil
Seligeria pusilla (Hedw.) Bruch et Schimp. – 11: lime containing schist; 16, 19: shaded limestone rock
Syntrichia montana Nees – 15: exposed limestone rock
Syntrichia ruralis (Hedw.) F. Weber et D. Mohr – 3: exposed acidic rock and bark of *Fagus*; 4: acidic conglomerate rock; 7: schistose rock; 11: exposed acidic rock; 13: acidic rock; 16, 19: shaded limestone rock
Syntrichia subpapillosissima (Bizot et R. B. Pierrot ex W. A. Kramer) M. T. Gallego et J. Guerra – 11: exposed acidic rock
Taxiphyllum wissgrillii (Garov.) Wijk et Margad. – 19: shaded limestone rock
Thamnobryum alopecurum (Hedw.) Gangulee –19: at the stream
Timmia bavarica Hessl. – 16, 19: shaded limestone rock
Tortella fragilis (Hook. et Wilson) Limpr. – 11: exposed acidic rock
Tortella inclinata (R. Hedw.) Limpr. – 15: exposed limestone rock
Tortella tortuosa (Hedw.) Limpr. – 2: schistose rock; 3: exposed acidic rock; 11: lime containing schist; 13: acidic rock; 15: exposed limestone rock; 16: shaded limestone rock; 19: shaded limestone rock
Tortula atrovirens (Sm.) Lindb. – 6: sandy loess wall
Tortula schimperi M. J. Cano, O. Werner et J. Guerra – 14: soil
Tortula subulata Hedw. – 1: acidic rock; 3: exposed acidic rock; 4, 7, 8, 14: soil; 11: lime containing schist; 12: sandy conglomerate loess wall; 16: shaded limestone rock; 19: shaded limestone rock and decaying wood
Trichostomum crispulum Bruch – 17: limestone rock
Weissia brachycarpa (Nees et Hornsch.) Jur. – 14: soil
Weissia condensa (Voit) Lindb. – 11: soil
Weissia controversa Hedw. – 11, 14: soil